

New Hampshire Space Grant Consortium
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PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The New Hampshire Space Grant Consortium is a Designated Consortium funded at a level of \$575,000 for fiscal year 2011.

PROGRAM GOALS

The strategic goal of the New Hampshire Space Grant Consortium (NHSGC) is: *To stimulate and enhance awareness and understanding of our nation's continuing quest into space by providing 1) Support to New Hampshire's college and university students in space-related fields; 2) Space-related educational materials, programs, and resources to the State's educators; and, 3) Greater access to space-related information and technology for the benefit of the State, its businesses, and citizens.* Particular emphasis and priority are given to the following goals:

- Providing fellowships, scholarships, and internships to the State's graduate and undergraduate (including community college) students pursuing studies in NASA-relevant science, engineering, and technology disciplines
- Providing resources, information, and training to the State's and region's educators in science, math, and technology
- Creating increased access to NASA-relevant science and technology through informal educational institutions and other programs oriented towards the general public
- Providing support for the State's community colleges
- Creating a greater impact on recruitment of underrepresented groups
- Providing pre-service and in-service science teacher training
- Supporting informal education/public service programs

- Fostering New Hampshire's new EPSCoR projects

The NHSGC partners are the University of New Hampshire (UNH), the UNH Cooperative Extension, Dartmouth College, FIRST Place, the Community College System of New Hampshire (CCSNH), the McAuliffe-Shepard Discovery Center (MSDC), Plymouth State University (PSU), the Mount Washington Observatory (MWO), the Margret and H.A. Rey Center, and BAE Systems of North America. The Consortium SMART objectives established in the base proposal (submitted in 2010) are:

SMART Objectives

Outcome 1

- Match or exceed New Hampshire non-Asian/non-Pacific Islander minority higher education enrollment of 5.4% in ethnic diversity of fellowship and scholarship awardees
- Support two undergraduate students at a Historically Black College/University in STEM-related programs and also participating in the undergraduate research symposium at UNH
- Match or exceed 55% women award participants for fellowship and scholarship awardees
- Provide 5.5 graduate fellowships
- Provide 32 undergraduate scholarships
- Provide opportunities for 20 students and faculty to participate in advanced seminar and research experience activities
- Support 14 internships in space science, meteorology, aeronautics, space education
- Provide two undergraduate internships at the MSDC (also germane to Outcome 3)
- Provide up to 25 plasma science seminars reaching 25 participants each
- Expand access to, and use of, remote imagery in New Hampshire through new data sets available through new web pages
- Expand access and use of remote imagery through the use of one new data set in at least 15 UNH Cooperative Extension workshops or courses.
- Provide longitudinal tracking of significant awards using the NSGF Tracking System

Outcome 2

- Support piloting of Phenology Climate Curriculum in one Elementary School classroom
- Support two Earth science/robotics teacher workshops for ten teachers
- Support Forest Watch (FW) expansion into five schools
- Support introducing ten FW teachers to new digital methods of measuring and monitoring
- Provide 50 MWO in-school programs reaching 1500 participants
- Provide 80 MWO distance-learning programs reaching 2000 participants
- Provide WMCC GIS Summer Camp for 10 middle school students (also germane to Outcome 3)
- Increase the number and quality of Dartmouth College outreach activities (also germane to Outcome 3)
- Support two NH high schools to participate in the FIRST Robotics competitions

- Sponsor one eStart course with 10 participants and one instructor through CCSNH.

Outcome 3

- Support a three-day Aerospace festival reaching 800 members of the general public
- Evaluate MSDC exhibits and activities
- Support 3 staff in developing greater knowledge in astronomy and space science
- Provide hands-on citizen science programs to 116 participants in Waterville Valley
- Provide collaborative public education astronomy program to 148 in Waterville Valley

PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, OR 3)

Highlight for Outcome 1: A team of students from the Thayer School of Engineering at Dartmouth were selected for the 2011 NASA Reduced Gravity Student Flight Opportunities Program. Undergraduate students Sean Currey, Broghan Cully, Maxwell Fagin, Michael Kellar, William Voigt, and Julianna Scheiman worked on a project sponsored by NASA Glenn Research Center to design a porous media condensing heat exchanger that acts as a spacecraft cabin dehumidifier. The goal is to design a system that is smaller, less mechanically complex, and requires less maintenance than systems presently in use. Space Grant supported the students' June 2011 travel to Houston, Texas where five of the students took part in hands-on microgravity experiments with their prototype aboard NASA's reduced gravity aircraft (the "vomit comet").

Highlight for Outcome 1: Many Community College System students are non-traditional learners -- they may have a family, a mortgage, and be juggling a job along with their coursework. In January 2012, NH community college students faced a 7.7% increase in tuition to offset a 20% reduction in state support. The NASA Space Grant \$1,500 scholarship goes a long way toward making higher education possible for these students, who are also shareholders in NASA's vision:

"I am a non-traditional Electronic Engineering Technology student at NHTI with a passionate interest in robotics engineering and research. Though my interests encompass the entire field of civilian robotics, I am particularly interested in the design of educational robotics systems and electronic systems for navigation in complex spaces. I am also intrigued by the concept of navigation and mobility in low gravity environments; I would love to involve myself in some of NASA space program's automation research. I am truly excited about my education, and I hope that I can someday make an impact in the field of consumer and research robotics."

-- W.H., Gilmanton, NHTI Electronics Engineering

Highlight for Outcome 2: Student and teacher reactions to the K-12 Curriculum Supplemental Science Programs at the Margret and H.A. Rey Center:

"I normally don't like science, but the Rey Center makes it so fun and interesting! They take us outside.... Once when we were learning about the different types of trees, they

gave us pine needle tea, and when we were learning about the moon, they gave us a white ball and we could actually see the different stages of the moon!"

-- 5th grader at the Waterville Valley Elementary School

"The Rey Center Programs are outstanding! The staff coordinates with us to align the programs with our science curriculum. The programs are hands on, kid friendly and well prepared! I always learn something at a program and have fun!"

-- Teacher (K-2), Waterville Valley Elementary School

PROGRAM ACCOMPLISHMENTS

Outcome 1: Contributions to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals

Achieved Metrics for Outcome 1 SMART Objectives

- The consortium awarded 9.3% of its fellowship/scholarships to under-represented (non-Asian) minorities, exceeding the objective, and 5.1% for all direct funded students
- Support was provided to one undergraduate student from a HBCU/Elizabeth City State University majoring in chemistry. The student will participate in the Undergraduate Research Conference in April 2012 at UNH. Student is engaged in a research project with a UNH faculty mentor and has received an internship at UNH for the summer of 2012
- The consortium awarded 44.2% of the fellowship/scholarships to women participants, and 47.4% to women students under all direct funding (objective 55%)
- 14 graduate fellowships were provided through Dartmouth, UNH and PSU. (Note: PSU established a new graduate program and there was a shift of some undergraduate support into graduate support)
- 29 undergraduate scholarships were provided through the Consortium
- Opportunities and support was provided for students to present to Wetterhahn Science Symposium (Dartmouth) and the URC (UNH). Travel support was provided to 20 students and faculty to enable them to attend advanced seminars and/or research experience activities
- 33 higher education and research infrastructure internships were supported in engineering, space science, astronomy, earth science, meteorology, aeronautics, and science education and outreach
- Two of the undergraduate internships were at the MSDC
- 30 plasma science seminars were provided, reaching 25 participants each
- Expanded access to, and use of, remote imagery in New Hampshire was supported through archiving of Landsat Thematic Mapper and Land Cover data sets covering New Hampshire; these sets made available through new web pages (GRANITView.unh.edu)
- Expanded access and use of remote imagery through enhanced, user friendly, website was supported through Space Grant, superseding the need for one-on-one instruction at workshops

- Provided longitudinal tracking of student significant awards using the NSGF Tracking System

Using Space Grant (NASA and match) funds, we support student education and research in fields related to space physics, astronomy, remote sensing, aerospace engineering, mechanical engineering, Earth science, meteorology, technology, and other areas related to NASA interests. Dartmouth College, the University of New Hampshire (UNH), Plymouth State University (PSU), and the Community College System of New Hampshire (CCSNH) offer graduate fellowships and undergraduate scholarships. Dartmouth, UNH, PSU, and the McAuliffe-Shepard Discovery Center (MSDC) offer internships. At the graduate level, the objective is to attract a high-quality, diverse graduate student body in these fields. At the undergraduate level, the objective is to attract and retain students in these fields and to enhance their education by providing opportunities for them to supplement their standard classroom education by participating in authentic, cutting-edge research.

Workforce Development -- Graduate Student Fellowships

Dartmouth College awarded fellowships to 4 graduate students in the Physics Department, 3 in Earth Sciences, and 2 in the Thayer School of Engineering. Physics graduate student Matthew Broughton prepared an experiment for installation at South Pole Station. This entailed designing and procuring antenna hardware, followed by extensive tests and practice locally setting up the experiment system. He travelled to South Pole Station in January 2012, and set up the experiment that is now operating. Physics graduate student Meghan Mella analyzed data from a NASA sounding rocket launched two years ago, discovering a modulated low-energy ion population accompanied by low frequency plasma waves. This work is a portion of her PhD thesis to be defended in Spring 2012. She has lined up a post-doctoral fellowship in space physics and plans to continue her career in STEM. In the Earth Sciences, the student research topics included PhD research into the impact of arc terrain weathering on the global cycles of various elements (Strontium, Osmium, and Carbon); Master's research in the analysis of Osmium and Iridium at the K-T boundary (also called the Cretaceous-Paleogene event boundary); and Master's research into realtime observations of the Greenland under-ice environment (ROGUE). Both Master's students plan to enter doctoral programs.

Two graduate students in the Dartmouth College Thayer School of Engineering received space grant funding to support SuperDARN activities. An extensive characterization of the statistical properties of the variability observed in the high-latitude electric field was completed this past year by Space Grant PhD student Ellen Cousins. Her study used observations from the network of high-latitude HF radars known as SuperDARN. The results of this study were published in a recent article in the *Journal of Geophysical Research*. In addition, a model of the observed electric field variability has been developed, and a manuscript describing the results of this work is in progress. Also during the past year an investigation of meteor echoes observed in the Mid-Latitude

SuperDARN radars was undertaken by another Space Grant student, Beth McCubbin, who is currently writing her Master's thesis, including results from this project.

The University of New Hampshire (UNH) awarded two new one-year Space Grant fellowships in the disciplines of Natural Resources and Mechanical Engineering and supported four previously awarded, continuing fellowships. Chelsea Corr, the newly awarded Natural Resources and Earth System Science (NRESS) student, is in her third year toward her PhD degree. Her research focus is retrieval of aerosols, comparing data from urban Houston, Texas, with rural New Hampshire. She combines the chemistry of the aerosols with remote sensing (using AERONET, the NASA Aerosol Robotic Network coordinated by NASA GSFC) as well as in situ measurements. Amy Underwood is a first year Master's student in mechanical engineering. Amy is designing a navigation controller for a lunar rover. It will use a combination of star sensor and accelerometer data to ascertain the rover's location and attitude. The controller will tell the rover how much to move, and in which direction, such that the rover moves towards its point of interest. It is designed to make the rover autonomous, which is particularly important in scenarios such as exploring a crater where communication with an outside base may be impossible due to geographic obstructions. Amy is also acting as a graduate student mentor to the UNH Lunabots team.

Plymouth State University (PSU) supported two graduate fellowship stipends and tuition waivers in Applied Meteorology. One student has nearly finished her Master's thesis on the validation of statistical classification methods for warm-season convective wind forecasting for the vicinity of Cape Canaveral Air Force Station and Kennedy Space Center (KSC). The purpose is to improve weather forecasting support for range operations at the Space Center. The second student is just starting her research, which although Space Grant funded, is aligned with one of the State's new EPSCoR projects.

In the Graduate Student Prizes program at Dartmouth College, Space Grant sponsors two awards given annually to selected graduate students in the space science, engineering or remote sensing fields, from among candidates nominated by faculty members. One award goes to a PhD student and the other to a Master's degree candidate. The goal is to recognize excellent students, hereby encouraging excellence among the students and giving the best students an award to list on their curriculum vitae. Dartmouth has awarded at least one of these awards almost every year since the inception of the program; in some years, two students have shared the award. The award has become quite competitive with many nominations in a typical year. Nominations are circulated to a panel consisting of one faculty member from each Space Grant department (Physics, Earth Sciences, and Engineering). The panel determines the awards based on the merits of the nominees. Excellence in research is the primary criterion, but departmental and community service and teaching are also considered. Typically at least one panel member has served on the previous year's panel, to provide continuity in judging the criteria. This year may be the most difficult decision ever, as four highly qualified students have been nominated, two from Physics, one from Earth Sciences, and one from Engineering. The prizes will be awarded at the end of the academic year.

Workforce Development -- Undergraduate Scholarships

PSU awarded three undergraduate scholarships to seniors in Meteorology. These students have received partial support by Space Grant for three years. Upon graduation, one student is seeking to continue her education in a graduate program in meteorology and the other two are seeking employment opportunities in a STEM field. One of the undergraduate students has been selected to present a poster on her research on Capitol Hill in April of this year. She is one of only 74 students selected for this event, out of a pool of 750 students nationwide.

The Community Colleges of New Hampshire Foundation continued its popular “Space Grant Scholarships” by awarding undergraduate scholarships to 25 promising students in STEM disciplines within the seven campuses of the Community College System of New Hampshire (CCSNH). The scholarship program is designed to promote and encourage enrollment in STEM technical degree and certificate programs with a focus on attracting minority and under-represented students. Public Service Company of New Hampshire (PSNH) has supported the Community College System as the business partner match in this scholarship program for the past 11 years. The goal of the program is to encourage careers in STEM disciplines, particularly graduates with skills of interest to NASA. In FY 2011, the Foundation received 35 applications and made 32 x \$1,500 awards to 25 students: 6 are female. In the three rounds of funding (summer 2011, fall 2011 and spring 2012), five students received two awards, and one student received three awards. The represented disciplines included aviation technology and aircraft construction (10 awards), electrical engineering (5 awards), science/math education (7 awards), and technicians (3).

Space Grant has teamed with the Northern Ecosystems Research for Undergraduates (NERU) program at UNH to support a sophomore chemistry undergraduate from a minority serving institution Elizabeth City State University (ECSU). The scholarship requirements include the student’s participation in the UNH Undergraduate Research Conference in April 2012, an in-house internship at UNH with UNH faculty mentoring for up to a year, and an expressed interest by the student in pursuing graduate studies at UNH. Only one ECSU student this year met the requirements for scholarship support. The student will have a NSF-sponsored summer internship at the UNH Institute for the Study of Earth, Oceans and Space (EOS). Mentorship by UNH faculty began during the spring semester to prepare the student for the topic to be researched this coming summer, and mentoring will continue in the fall for follow up interpretation and a possible student presentation at the American Geophysical Union meeting in December. This year’s mentor is a member of the Department of Earth Sciences and EOS, with research focusing on aspects of global climate change.

Workforce Development – Higher Education Internships and Hands-on Experience

Internships are carried out and completed under the supervision of sponsoring researchers. For many of the undergraduate interns at Dartmouth College, including all Women in Science Project (WISP) interns, the culminating experience is the completion of a poster to display at the Wetterhahn Science Symposium held each May. At UNH the intern students are encouraged to present posters at the Undergraduate Research Conference (URC).

The Women in Science Project (WISP) at Dartmouth College is a support program for women undergraduate science majors. The WISP Research Internship program provides first and second year undergraduate women with paid, part-time research opportunities with senior researchers. Interns present their research in a poster at the annual Wetterhahn Science Symposium in May of each year. Interns also attend events where they meet professional women scientists, such as the recent luncheon with Anthea Coster, a Research Scientist at MIT Haystack Observatory, whose research involves the acquisition and integration of distributed array instrumentation data (such as GPS) for use by the atmospheric science community. Other planned events include panels on career paths and two career couples. The WISP interns engage in pre-college outreach activities, such as the Women in Science and Technology (WIST) Forum held at the White Mountains Community College (discussed under Outcome 2). Space Grant supported 8 WISP Research Internships this reporting period and provided funding support to another 6 WISP students.

UNH undergraduate engineering student William Holmes received a summer internship that gave him hands-on experience through his development of the TableSat IB prototype for the NASA Magnetospheric MultiScale (MMS) Mission. The student worked with other undergraduates to design, build and test a table top prototype of the MMS spacecraft for the purpose of analyzing spacecraft dynamics and application of attitude (rotation and nutation) control. This specific design is designated the MMS TableSat IB, with limited 3-degrees of freedom (full rotation and limited nutation). It is a redesign and rebuild of the original MMS TableSat IA prototype. This work is in support of ongoing research Professor May-Win Thein and her graduate students are performing for the NASA MMS Mission (sponsored by NASA GSFC). The metrics and evaluation methods in this summer internship are primarily based upon comparison of the student's TableSat IB prototype to the original TableSat IA prototype. One of the main improvements is the incorporation of a pneumatic system that more closely mimics the MMS spacecraft thrusters than the original actuator fans on TableSat IA. In addition, further nutational motion has been achieved than was possible with TableSat IA. The intern and his team were responsible for developing the suite of electronics, sensors and data acquisition systems. The work performed as an incoming Junior (before taking the dynamics and systems and control classes that this project requires) is comparable to that of introductory level graduate work. The results were presented and proceedings published in the 22nd Space Flight Mechanics Symposium in February 2012. The student and his colleagues traveled to NASA GSFC to report the results of the summer research project to aerospace engineers of the Attitude Control Systems Engineering Branch at GSFC in November 2011.

At PSU, two graduate students were supported with summer research stipends. In addition to the fellowship recipient already mentioned earlier, another Master's student in meteorology worked on a comparison of variable updraft melting layer heights to convective wind speeds using polarimetric radar data. His research is relevant to KSC launch operations. The summer research stipends helped the two graduate students make outstanding progress, allowing them to complete their theses in a very timely manner.

Two Space Grant interns were recruited by the McAuliffe-Shepard Discovery Center (MSDC) and selected through an open process (advertising on the MSDC website and in a statewide newspaper, through the State of NH opportunities web pages). One intern had just completed his freshman year at Stanford with hard science and engineering coursework, and was leaning toward an aeronautics and astronautics major. The other intern had just completed his sophomore year at Rensselaer Polytechnic Institute, and had declared aerospace engineering as his major. The interns developed materials for K-12 student workshops, presented planetarium shows to the public, created informal science demonstrations, activities and workshops as part of their Outcome 3-based assignments. Additionally, the interns researched aerospace companies doing work in the six New England states, had training in interviewing techniques from a science writer, and then interviewed aerospace companies doing work primarily in NH and MA. This allowed them to develop relationships to enhance the Discovery Center's ability to create future exhibits on commercial aerospace endeavors while also networking with aerospace scientists and engineers, developing relationships that could potentially lead to future employment.

Space Grant funded an astounding nine undergraduates in the Dartmouth College Physics Department for intern activities ranging from Outreach, to research, to the NASA Academy. As a research intern, Dartmouth physics undergraduate Michael Chilcote developed simulation tools for radio science experiments, and then tested the tools by performing experiments over radio signal paths spanning northern New England. As part of this work, he traveled to New York and Massachusetts where he set up and tested radio-receiving systems. The work will comprise his senior honors thesis to be submitted in May 2012. He has been accepted to several graduate schools and plans to continue his education in STEM. Dartmouth undergraduate Kendall Farnham, a first-year female physics student, analyzed radio receiver data from a station in Alaska to determine whether certain observed radio emissions were related to Jupiter.

Through the NASA Academy and summer internship programs, our universities support undergraduates with an interest in NASA-related fields desiring summer internships at a NASA center, and this in turn enhances connections and collaborations between these institutions and the NASA centers. Last year, as is typical, several students from Dartmouth applied for internships at NASA centers. Full support (stipend plus travel) was awarded to Dartmouth undergraduate Jacob Wolf, who spent the summer of 2011 at Goddard Space Flight Center participating in the Lunar and Planetary Science Academy (LPSA). His individual research project was titled, "Simulating the Electrical Environment of Lunar Craters near the Terminator." He also participated in a geological field expedition with the academy to aid the individual research project of another intern.

Jacob writes, "My summer with the Lunar and Planetary Science Academy allowed me to understand the fields Space Science and Engineering in both broad and specific ways, and will help guide me in future schooling and careers in engineering and space." As part of the evaluation of this program, Dartmouth requires and received a lengthy report from the student on his activities asserting that the internship was a valuable and successful experience.

Workforce Development -- Higher Education Support for Seminars, Conferences, Research Supplies

Space Grant supports the Undergraduate Research Conference (URC) hosted by UNH that features undergraduate research that contributes to, or benefits from, an interdisciplinary science and engineering perspective. The categories include Earth Sciences, Environmental Science, Chemistry, Civil Engineering, Environmental Engineering, Chemical Engineering, Computer Science, Electrical and Computer Engineering, Mechanical Engineering and Physics and Mathematics. The program includes a poster session and informal discourse with UNH faculty and the general public. This year's event is under planning for April 25, 2012, and has 135 students registered. Space Grant supported WISP student poster printing costs associated with the Wetterhahn Science Symposium at Dartmouth College.

Plasma seminars contribute to both higher education and research infrastructure by providing a regular forum for discussing ideas and inviting outside researchers to discuss ideas. The space physics community at Dartmouth consists of 5-6 faculty members in the Physics Department and 2-3 faculty members in the School of Engineering. With associated post-docs, students, and staff, there are 30-40 scientists and engineers in the discipline at Dartmouth. The plasma seminar is the most important weekly event that brings together this scientific community. It plays a critical role educating students, initiating new collaborations and enhancing existing ones, and disseminating the newest knowledge in the field. Aside from very occasional thesis defenses, this seminar is the only time when the entire space physics community at Dartmouth meets and discusses in one room. There are 30 seminars per year, with varied topical speakers. This past year, the guest speakers included scientists from St. Michael's College, University of Massachusetts (Lowell), AFRL, Hanscomb AFB, University of Calgary, University of Colorado, Boston University, Harvard CfA, the Johns Hopkins Applied Physics Laboratory, NASA, Southwest Research Institute, Florida Institute of Technology, Princeton Plasma Physics Laboratory, and the MIT Haystack Observatory.

Space Grant also sets aside funds to support graduate and undergraduate research for the purpose of travel or the purchase of parts and supplies. The objective is to assure that the Space Grant fellowships and internships are successful. The UNH fellowships include an additional allowance for each student's use. At Dartmouth College, Space Grant enabled a team of five Dartmouth undergraduates to travel to Houston to participate in microgravity experiments (flight dates June 2-11, 2011). The students designed and tested technology for dehumidification of the cabin environment, and submitted a report. Plymouth State University students went to the 11th Annual

American Meteorological Society Student Conference (New Orleans, LA) and the 37th Annual Northeastern Storm Conference (Rutland, VT).

Higher Education Faculty Curriculum Support

The Community College System currently offers over 800 on-line courses throughout its seven colleges. In order to keep pace with and improve the quality of 100% online math and science courses, the Community College System's Department of Distance Learning is using *eDesign*, an on-line instructional design resource center. eDesign is a quality assurance rubric for courses taught online. The program provides access to a variety of resources to enhance an instructor's knowledge, skills, and attitudes towards teaching online, as well as a framework for reviewing the quality of online course design. NASA Space Grant was used for faculty stipends and the eDesign software, to increase the quality of 100% on-line Math and Science courses by using the web enabled e-Design Course Quality Rubric and follow up with training for faculty.

A new engineering course on Fundamentals of Space Systems was developed and taught in the 2012 winter quarter at Dartmouth College. The course was co-developed and co-taught by the Space Grant Visiting Young Scientist (VYS), two senior engineering graduate students, and a senior engineering professor. In addition to lectures and weekly homework, a novel aspect of the course included a significant design component. The class was divided into teams of 3-4 students in the second week and, over the course of the term, each team developed a conceptual design for a satellite mission that included design strategies for astrodynamics, launch and propulsion, attitude determination and communication and telemetry. The design teams used the industry-standard Computer-Aided Design (CAD) software, Satellite Tool Kit (STK), in developing their design concepts. Their projects culminated with final presentations and written reports detailing the mission design. Eleven students, including seniors and MS and PhD candidates, took the course. The end-of-term evaluations indicate that overall the course was a major success. Some students in the class have applied for internships at NASA centers this summer.

Space Grant supported the revision of a joint course by the Earth Sciences and Geography Departments at Dartmouth College. "Remote Sensing", course EARS 65/GEOG 55, was taught by Jonathan Chipman to 18 students.

Higher Education Faculty Professional Development

The Nashua Community College (NCC) is an FAA approved training facility. The Associate in Science Degree in Aviation Technology (AT) prepares men and women for professional careers in aviation maintenance. This is a 21-month curriculum that covers a wide variety of subjects concerned with airplanes: reciprocating engines, turbines, fuel systems, propellers, ignition, electrical systems, and hydraulic systems. Aviation Technology students have a strong background in physics, electronics, and computer programming. With the NASA Space Grant, our goal is to supplement and enhance this program by offering professional development for community college educators. Supported by the NH Space Grant, the head of the NCC AT department will attend (May

2012) a course entitled Piston Engine Service School at the Pennsylvania College of Technology specifically designed for instructors. Conducted at Pennsylvania College of Technology's airport facility, the Service School is a comprehensive four-day, hands-on, refresher course on Lycoming's current production piston aircraft engines. Recognized as one of the leading centers of aviation education in the country, Pennsylvania College of Technology has been solely appointed and authorized by Lycoming to conduct the Lycoming Piston Engine Service School.

Space physics, remote sensing and related disciplines can be effectively combined with teaching in small college settings for general training of students and for attracting students into areas of national need. However, because these disciplines fall in between or outside of mainstream departments defined at most small colleges, scholars in these areas are often disadvantaged when applying for positions. Teaching experience can make a big difference in making these scholars attractive to small college faculties. Dartmouth College initiated the Visiting Young Scientist (VYS) program specifically to offer an opportunity for scholars within five years after completing their PhD to obtain teaching experience. As a secondary objective, the visiting scholar benefits Dartmouth faculty and students directly by collaboration in research as well as teaching. This highly successful program has resulted in at least one visiting scholar per year for seven consecutive years. Several of these scholars have gone on to become well-known in their fields; for example, Mike Wiltberger, an early visiting fellow, is now an active space physics researcher based at NCAR, and Robyn Millan, a former visiting fellow, is now assistant professor at Dartmouth and PI of a high-profile NASA balloon program. Michael Rawlins, a relatively recent VYS, obtained an academic position at U-Mass Amherst and has been retained in a field related to NASA interests. Last year's VYS, Sarah McGregor, has taken a space-physics research position at Boston University. In 2011, the faculty committee at Dartmouth received and reviewed four applications for the VYS position. They selected Jeremy Ouellette from Raytheon Corporation. Ouellette was in residence starting Oct 1, 2011. He co-taught a new course in space technology in the engineering school, April 2010. In Winter 2012, he co-taught Engineering 199, a new course on space technology for which his industry background was an important component. In Spring 2012, he is co-teaching Physics 111, kinetic theory, which is closely related to his research which uses kinetic models of plasmas. He has also presented a seminar to the space physics community at Dartmouth.

Research Infrastructure

Space Grant support to the Cooperative Extension enabled acquisition, hosting and public access of an archive of Landsat Thematic Mapper (or TM) data sets covering New Hampshire. Two data sets of particular interest to the user community that have been added to the archives in the past year include 2011 1-meter National Agricultural Imagery Program (NAIP) imagery, and 2-meter LiDAR data for coastal NH. The Extension has also updated the NH land cover data set. The GRANIT 2001 Land Cover data set describes 23 classes of land use/land cover. It was initially processed from 12 TM images, acquired over the period 1990 to 1999. During the current reporting period, GRANIT staff continued their effort to utilize image-processing methodologies applied to

current TM imagery to update areas mapped as cleared land. They utilized TM images from two dates – August of 1999 and August of 2009, to conduct a change analysis and thereby isolate areas that had been cleared. The image processing is complete and the requisite post-processing editing is nearing completion. Once the data are finalized, GRANIT staff will conduct an accuracy assessment and publish the updated, statewide data set. The GRANIT data sets are made available to the public through multiple mechanisms, including standard distribution via DVD/ftp, and access via Web Map Services for the most frequently requested data sets. They are also making the most popular image data sets available through the recently launched GRANIT Data Viewer (GRANITView.unh.edu).

A new program “UNH NASA Research Initiative” was launched at UNH to support faculty in developing infrastructure for research projects, including establishing new collaborations and supporting student research. Two such projects were awarded. One \$10,000 award went to support an undergraduate student intern for a new faculty member in the Physics Department at UNH. The project “Chaotic Solar Motion and its Coupling to Solar Cycles” is still in progress. The student has been accepted into graduate school in Physics. The second \$10,000 award went to a female faculty member in the Earth Science Department, Prof. Ruth Varner, who heretofore had limited experience with NASA collaborations. She initiated a global climate change study entitled “Ebullition of Methane from Flooded Environments: Measurements and Scaling of this Important Greenhouse Gas”. The Earth’s polar regions are warming at a faster rate than other any other latitude. Permanently frozen soils or permafrost, are thawing at an increasing rate, exposing stored soil carbon. Feedbacks to thawing permafrost include changes in vegetation and hydrology that in turn impact the carbon that is stored in these peat lands. Carbon can be released from these ecosystems to the atmosphere as a gas in the form of carbon dioxide or methane. This project focused on the release of methane as bubbles from these peat lands and the adjacent lakes. Prof. Varner and a graduate student were able to build and deploy sensors to measure the bubbling or ebullition of methane at two remote locations in the subarctic region: Fairbanks, AK and Abisko, Sweden. Using a newly developed acoustic technique, they were able to detect on a continuous basis, the timing and size of bubble events. This kind of data allows identification of both the controls on this emission pathway and the potential impact on the atmosphere. This data has been processed and is the basis for two publications in preparation, three presentations and has been used in two proposals for funding. The study established a collaborative effort with participation by NASA GSFC, University of Alaska, Fairbanks, Guelph University, and Stockholm University. Space Grant provided support to the graduate student, Ms. Jillian Lennartz. She completed her M.S. in Geochemistry in August 2011.

Longitudinal Tracking

The National Space Grant Foundation Tracking System is used to track our NHSGC students. The percentage of students who have been successfully tracked to their “next step” are 58% for 2006, 84% for 2007, 86% for 2008, 96% for 2009, and 100% for 2010. For 2011, all participants are still enrolled.

Since 2006, 79% of our graduates who received significant Space Grant support have gone into a next step STEM discipline, such as NASA, the aerospace industry, or academia.

As an example, Dr. Sarah Jones received an UNH Space Grant fellowship in 2006-2007 and graduated in 2010. She is now working at NASA Goddard Space Flight Center as a Research Astrophysicist (Particles and Fields). She recently became the principal investigator (PI) for the Thermospheric Temperature Imager on FASTSAT. She is working on an Internal Research And Development project to develop a means of optimizing and calibrating the optics of a new extremely high resolution Fabry-Perot interferometer, an advancement of the interferometer used on the FASTSAT experiment. She is also currently working on a rocket proposal to study the production of nitric oxide in pulsating auroras. Part of the motivation is that the nitric oxide that is produced by aurora can transport to lower altitudes over a timescale of months and then interact with and deplete ozone, with potential weather/climate effects.

Mr. Michael Conti participated in the NASA summer internship program (SIP) in 2004 and NASA Academy (GSFC) in 2005, both awarded through NHSGC. Michael became a mechanical systems engineer at Orbital Science Corporation and for the past six years has been working on the structural design of geosynchronous communication satellites.

James Lundberg, who received Space Grant Fellowships 2007-2009, this coming year will begin working as a researcher for the Air Force Research Laboratory on problems related to plasmas for the purpose of improving communications with spacecraft and aircraft.

In 2011, 64 students took next step (NHSGC students supported from FY06-FY11 funds): 17 are pursuing advanced degrees in STEM disciplines; 3 accepted STEM positions at NASA contractors; 21 accepted STEM positions in industry; 3 accepted positions at NASA; 7 accepted STEM teaching positions in K-12; 7 accepted STEM positions in academia; and 6 went on to positions in non-STEM disciplines.

Outcome 2: Attraction and retention of students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty, and K-12 pre-college programs.

Achieved Metrics for Outcome 2 SMART Objectives

- The Phenology and Climate curriculum was delivered to 26 students and two teachers at the White Mountain Regional High School, and the Phenology field research module to 40 PSU undergraduates. The new Mountain Weather curriculum was delivered to 17 middle school students at the Holderness Central School
- Two workshops, one on land cover/use and the other on astronomy, were held in the “Science Teacher Training North Country” initiative, serving 13 upper elementary and middle teachers

- Forest Watch network was expanded with the addition of teachers from 11 new schools, covering NH, ME, MA, and VT
- Thirteen new teachers and one returning teacher were indoctrinated into new digital methods of measuring and monitoring white pines, as part of the Forest Watch program
- MWO in-classroom, field trips, and distance-learning programs combined reached 3000 students and 100 teacher participants
- White Mountain Community College (MWCC) GIS Summer Camp served 21 middle school students
- Dartmouth College Student Outreach program expanded participation in several Outcome 2 and 3 venues, including Women in Science and Technology (WIST) panels for 90 middle/high school women students considering STEM careers (Outcome 2)
- Two NH high schools (Manchester Central and St. Thomas Aquinas) received support to participate in the FIRST Robotics competition
- Support was provided for the eStart course, Biology 1, through CCSNH. A total of 25 students participated --10 in fall semester 2011 and 15 in spring semester 2012

Pipeline Activities -- K-12 Teacher Development and STEM Curriculum Enhancement

The objective of the Rey Center's science curriculum enhancement programs is to augment and improve the life science, Earth/space science, and chemical/physical science and inquiry components in science education in New Hampshire's K-12 schools and are aligned to the New Hampshire SAU 48 Science Curriculum. Rey Center staff members are directly involved in the implementation of the in-classroom supplemental science curriculums engaging teacher's pre- and post- implementation. Use of Space Grant supported materials is confirmed through discussion with Rey Center staff and direct observation by Rey Center staff. The Rey Center delivered approximately 60 supplemental science programs to Waterville Valley Elementary School's K-8 students from September 2011 through (planned) June 2012, equivalent to 600 contact hours with its 40 students. One third of these programs were specifically directed toward middle school students (grade 6-8).

The Rey Center also delivered its research-based Phenology and Climate curriculum to two high school teachers and 26 students at White Mountain Regional High School, equivalent to 132 contact hours. Teachers and students were guided through data collection, synthesis and analysis and encouraged to continue phenological and climate monitoring. Additionally, the Rey Center delivered a Mountain Weather curriculum, developed by a Plymouth State University graduate student with the guidance and support of Rey Center staff, to 17 middle school students at the Holderness Central School, equivalent to 51 contact hours. Lastly, the Rey Center delivered the field research module of its Phenology and Climate curriculum to 40 Plymouth State University undergraduate students, equivalent to 80 contact hours.

In a new initiative "Science Teacher Training North Country", Space Grant supported Education and Science faculty and graduate students from the University of

New Hampshire in a partnership with personnel from the New Hampshire's North Country Educational Services to create teacher professional development workshops for upper elementary school and middle school science teachers in rural northern New Hampshire. The two-day workshops were team-taught by scientists and teacher educators to insure an integrated approach to teaching how to successfully teach science to underserved public school students. Northern New Hampshire is such an area of need as it is a rural, impoverished area of New Hampshire. Many of the middle school science teachers do not have a certification in science and they have stated a strong desire for professional development in the area of science content. Two workshops took place in August 2011 and focused on land cover/use and astronomy. The land cover/use workshop was taught with the help of a doctoral student in the Natural Resources and Earth Systems Science PhD program. The workshop focused on how to monitor the landscape for signs of change through inquiry including field-based techniques as well as with the use of satellite images. The physical science workshop taught by the Director of NH Space Grant (who is a research professor in Astrophysics at UNH) examined gravitational forces and planetary motion through the use of computer simulations. In order to support the transfer of successful science teaching in the classroom, teachers learned about how to use the workshops' instructional techniques to motivate early adolescents to learn science from a science educator and an educational psychologist from the UNH Department of Education faculty. As a follow up to gauge the effectiveness of the workshops, an email survey was sent to the teacher participants: 9 out of 13 teachers reported using some aspect of the material learned in the workshops in their classrooms. Two teachers have volunteered their classrooms to be part of the doctoral candidate's research on the study of sugar maples.

Forest Watch conducts basic and applied research on forest systems in New England, with data collected by teachers and students in K-12 within the region. Educational objectives of Forest Watch include building K-12 students' interest in and aptitude for science, technology, and math while engaging them in authentic science using 21st century technology. The program is evaluated by the participating K-12 teachers. Space Grant supports teacher workshops and student conferences for this program, as well as a graduate student intern whose dissertation will incorporate the data. The most recent workshop was held at UNH in February of this year. This past year, 13 new teachers and one returning teacher were trained on the usage of spectrophotometric measures of leaf or needle reflectance and what those indicate about plant health and correlate with biometric measures. Some have collected white pine samples already. The teachers represent 11 schools in New Hampshire, Maine, Massachusetts, and Vermont. Four of the schools are high schools.

Mount Washington Observatory (MWO) provided a 2-day teacher workshop with sessions on STEM education and hands-on activities for the classroom. Seven teachers participated.

Pipeline Activities -- K-12 Student Hands-on STEM Learning Activities

Mount Washington Observatory (MWO) educational programs sponsored by

Space Grant include: outreach (classroom visits), distance learning (live videoconferences of K-12 classrooms with MWO staff) and field trips (students, teachers and general public visiting Weather Discovery Center and the Mount Washington Museum), which offer authentic, hands-on experiences in science for students as well as engaging middle school teachers in hands on curriculum enhancement. The content presented in each of these formats includes: an understanding of data collection, weather patterns, instrumentation used to make a weather observation, climate system, alpine environment, and the use and maintenance of remote technology (automated weather stations). Through the distance-learning program we have the opportunity to bring students, virtually, to the Mount Washington Observatory's weather room located at the summit of Mount Washington. By showing the students the current weather at the highest peak in the Northeast and explaining MWO operations accompanied with educational content that is specific to each program allows the students to gain more knowledge about our atmosphere. They also have the opportunity to speak directly to a scientist. In the beginning of each program it's rare that you see a student raise his hand when we ask, "Who loves science?" At the end of each program the Meteorologist asks, "So, who likes science now?" At that point, all hands go up in the air enthusiastically. It's very exciting and encouraging to see. Through this programming the MWO education staff has had the opportunity to have direct contact with over 3000 students and 100 teachers in the past year.

PSU Space Grant participated in Science Day activities at the Indian River School in Mascoma, NH (a designated NASA Explorer School) and at a weather station dedication at the Hampton Middle School. In both activities, PSU faculty and students launched weather balloons and answered the middle-school students' questions. The balloon launch activities were to attract student interest in atmospheric science by showing some of the tools used by meteorologists for assessing the atmosphere. It provided them with insight on the equipment and the data provided.

White Mountains Community College and the North Country Health Consortium partnered for a Science, Technology, Engineering, and Mathematics camp (July 11 & July 18, 2011). The STEM camp, designed for students entering grades 6 through 8, provided hands-on, fun-filled activities that are meant to be introductory, interactive, and project-based. Some of the topics covered included: Wilderness rescue and research, rocketry, and Lego Robotics. The camp is designed for students who are interested in the world around them and the way things work. Twenty-one students participated in 2011. The WMCC STEM camp is co-supported by the New Hampshire Experimental Program to Stimulate Competitive Research (NH EPSCoR).

Pipeline Activities - STEM Recruitment in the High School

The Women in Science and Technology (WIST) Forum planning is underway by FIRST using Space Grant support, for an event to take place in November 2012 in Manchester, NH. The Women in Science and Technology Forums provide middle/high school women with a unique opportunity to meet, listen to, and talk with professional women who have successful careers in science, engineering and technology. The White

Mountains Community College (WMCC) WIST is patterned after the WIST Forum originated by FIRST. Space Grant fellowship and higher education supported students (present and former) from UNH and Dartmouth, including the new NHSGC Assistant Director (and previous Space Grant fellowship awardee), participated in the second annual WMCC WIST event in April 2012, held in Berlin, NH. Panelists who presented their learning and career paths included specialists in chemistry, climate change, space science, forensic science, environmental science, atmospheric chemistry, wildlife biology, civil, mechanical, bioengineering and others. White Mountain's WIST program is serving as a model for the other six Community Colleges throughout the state. Great Bay Community College is already considering putting a WIST forum together for the seacoast region.

The Dartmouth Graduate Student Outreach initiative benefits the broader community by sponsoring Dartmouth students to participate in outreach events, and to benefit those students by instilling in them the value of communicating space science to the public. These events are targeted toward K-12 (Outcome 2) and general public (Outcome 3). Seven students and two post-doctoral scholars participated in qualified outreach events, some multiple times. Two events deserving of special note are: the New Hampshire Space Grant 20th anniversary held at Durham in June 2011 (which engaged 63 middle and high school students and more than 200 general public), and the WIST Forum panel discussions held in Berlin by White Mountain Community College on April 6, 2012 (which engaged 90 young women from rural middle and high schools). Dartmouth contributed three exhibits to the anniversary celebration, related to astronomy (3D representation of crab nebula), presentation of student balloon experiments, and magnetospheric physics (animated magnetosphere model). Dartmouth VYS Sarah McGregor and former VYS Michael Rawlins also participated in the Northeast Regional Space Grant meeting; Rawlins presented a talk. Two Dartmouth students, Alison Stace-Naughton and Elizabeth Gillaspay, participated in the panel review held at WMCC. Alison, president of the Society of Women Engineers at Dartmouth, sat as one of four participants in a panel review attended by approximately 50 high school students, and talked with many of them after the panel discussion.

Two high school FIRST Robotics teams received Space Grant support: St Thomas Aquinas Robotics Team (STAR) in Dover, NH, and Manchester Central High School's CHAOS team in Manchester, NH. The CHAOS team won the Granite State Regional Competition, with 50 high school teams competing. The St. Thomas Aquinas High School (FIRST Team #1307) was started in 2003-2004 with support from the NHSGC and UNH. For this year's competition, 30 students constructed a 120-lb robot designed to pick up and launch foam basketballs into a set of hoops on the playing field. The robot also needed to overcome obstacles built into the field. Students were given six weeks to construct and test the robot prior to the competition. Working in concert with mentors in technical fields, the team developed a variety of skills, including: Mechanical design, materials procurement, construction, and testing of drive trains and mechanisms needed to accomplish the competition task within the competition restrictions; Electrical wiring (and soldering) necessary for the robot's electronics to function; Programming of the robot's function using National Instruments' Labview software, and control of the robot

using a professional grade National Instruments cRIO system; Design of the robot using Autocad Inventor software; Development of a system for controlling the robot using body motions and the Xbox Kinect motion sensor; Troubleshooting systems under the time pressure of the competition; and Teamwork and collaborative skills. Many students who have completed the St. Thomas Aquinas High School FIRST program have gone on to study engineering and the physical sciences in outstanding programs. In addition to a number of students studying engineering disciplines at the University of New Hampshire, we have alumni currently studying at the Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, Rochester Institute of Technology, University of Rochester, Clarkson University, and the United States Naval Academy, among others. Our STAR alumni have worked at iRobot, NASA, and for the Department of Defense.

The Community College System of New Hampshire has partnered with the Virtual Learning Academy Charter School (VLACS), to offer “e-Start” courses in which students earn dual high school and college credits for on-line courses. VLACS is New Hampshire's first statewide, on-line high school. Certified instructors teach the eStart courses. The goal is to use the latest internet technologies to provide students with anytime, anywhere access to a rigorous, personalized education. On-line learning is one of the fastest growing segments of the Community College curriculum. e-start courses are geared toward engaging high school learners through a discounted rate, transferable credits, and flexibility. The NASA Space Grant supports a STEM e-Start course, Biology 1. The course provides an introduction to the basic principles of biology, including the structure of cells, cellular respiration and biochemistry, physiological processes, genetics, and heredity. This is a fast paced course in which students are expected to spend a minimum of 10 hours a week on reading and on course assignments. Student participation this year was 10 (fall 2011) and 15 (spring 2012), an increase in enrollment over last year.

Outcome 3: Building strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA’s mission.

Achieved Metrics for Outcome 3 SMART Objectives

- Evaluation of the 2010 aerospace festival indicated 2 days as an optimal event duration. General public attendance at last year’s Space Grant supported 2-day festival was 400. This year’s Aerospacefest is in planning and on schedule for May 2012
- The evaluation of MSDC exhibits and activities is delayed
- Three staff were supported in informal education development: the MSDC Astronomy Educator participated in the Association of Science-Technology Centers Annual Meeting; the Producer and the Astronomer both participated in the Mutual Concerns of Air and Space Museums Annual Conference
- Citizen science programs served 34 participants in the Waterville Valley; through NH Tech Fest about 600 of the general public (at least half pre-college) were served;

MWO programs served 199 (ages 16 and up); and through New England Fall Astronomy Festival approximately 500 general public were served

- The Rey Center collaborated with the MSDC and the NH Astronomical Society in a series of public education astronomy programs that reached 742 members of the general public in Waterville Valley

Priming the Pump -- Engaging the General Public

The McAuliffe-Shepard Discovery Center partnered with a wide variety of informal and formal education providers in a strategic partnership/linkage to provide an aerospace festival with engaging STEM activities for hundreds of New England families. This year's event is May 4-5, 2012, and will feature planes that have and are pushing the envelope in flight – like the newly displayed XF8U-2 Crusader – and planetarium show *Attack of the Space Pirates*. This year's guest speaker is New Hampshire's Astronaut and Space Shuttle Commander Rick Searfoss, who will present "The Human Side of Human Spaceflight". Colonel Searfoss (USAF, retired) will share his experiences as a pilot astronaut on three Shuttle missions. Last year's event, also funded through Space Grant, featured visiting Astronaut Lee Morin. Dr. Morin inspired, engaged and informed Aerospacefest 2011 participants with a presentation on NASA space efforts, focusing on the Shuttle program, International Space Station and the future of manned missions, presenting awards to winners of the NH-wide high school Astronomy Bowl contest and the Alex Higgins Memorial Space Camp Scholarship program, and informally interacting with children, youth and families. Hands-on activities incorporating real-life problem-solving and needs included: rocket building and launching; designing and testing airplane models; talking with the iGlobe engineers about how they designed their planetary projection system and trying to manipulate objects in scenarios similar to Shuttle and ISS experiment stations; learning from the UNH student team for the NASA Lunabotics Competition, who designed lunar mining equipment, on how they solved engineering problems; seeing the planetarium show about asteroids and meteors, *Impact Earth*, and then handling meteorites and discussing with educators; using their cell phones to give orders to a 9" tall robot, talking with an engineer and sociologist about challenges and opportunities in colonizing the Moon and Mars. Children, youth and adults also watched weather balloon launches and spoke with PSU meteorologists as they tracked real-time data gathered by the balloons. Industry co-sponsors with Space Grant included Boeing Company and Nanocomp Technologies. Affiliate participation included UNH, BAE of NA, the Rey Center, and PSU, and NASA participation included the NASA Aerospace Education Specialist (GSFC) and the NASA Astronaut Office (JSC). Public attendance for this family event last year included over 220 parents/adults and over 180 pre-college students.

The objective of the Rey Center's *Citizen Science* programs is to create hands-on participation that creates meaningful learning experiences, improving the participant's science literacy and developing the knowledge and motivation that enables citizens to become actively engaged in making informed decisions about the natural environment. The Rey Center delivered its citizen science based Tecumseh Overnights program to 15 program participants during the summer of 2011. Tecumseh Overnights is a place-based,

environmental education program that guides small groups up Mount Tecumseh in Waterville Valley, New Hampshire for an overnight adventure that combines programs on northeastern ecology, climate change, and astronomy. The Rey Center also implemented its Water Watchers program June through October in 2011; Water Watchers creates a rich citizen science opportunity for the public to monitor the overall health of important local water sources. Staff and volunteers conducted 12 water-quality monitoring sessions. Staff engagement hours totaled 44 hours, with 19 participants.

The objective of the Rey Center's astronomy programs is to offer engaging activities in astronomy that increase public awareness of the importance of astronomy in society, improve science literacy, and foster a sense of wonder and excitement about astronomy and discovery in science. The Rey Center delivers a variety of public education programs in astronomy. In 2011-2012, the center delivered two programs in partnership with the McAuliffe-Shepard Discovery Center to 23 participants, eight programs in partnership with the New Hampshire Astronomical Society to 164 participants, two Family Astronomy nights serving local families, totaling 30 participants, and two astronomy programs at our annual Curious George Cottage Family Festival totaling 525 participants. The implementation of the new H.A. Rey Observatory, which was completed with assistance by the University of New Hampshire (Space Grant match) and several Rey Center members, has aided the Rey Center in hosting astronomy education programs by providing a physical location for astronomical observations and by serving as a visible advertisement of the astronomy programs.

The Mount Washington Observatory (MWO) offers two-day and one-day educational programs for ages 16 and up. The number of participants in the one-day programs totaled 139, while 60 participants were engaged in the 2-day programs. One offered program is called *Summit Adventure*. By collaborating with experts in the field MWO is able to offer an opportunity for participants (ages 16 and up) to immerse themselves in a topics such as climatology, geology and astronomy while spending a night at the Mount Washington Observatory. In November 2011 Director of Education at the McAuliffe-Shepard Discovery Center led a Summit Adventure called *Studying Stars from the Summit*. Six participants signed up for this particular Adventure and the trip exceeded expectations.

Over the past year the MWO education staff has developed a new program called *Techno in the Tundra*, which is part two (follow up program) to the already developed *Alpine Zone* program. While the *Alpine Zone* describes the environment above tree line (i.e. climate, weather, vegetation, wild life, etc.) on Mount Washington, *Techno in the Tundra* provides a closer look at the technology used to record the weather in this environment. The program refers to the Mount Washington Regional Mesonet, which is a series of remote sensors in and around the White Mountains that monitor weather data (temperature, humidity and wind speed). Through activities, photographs and video clips MWO education staff explain how these remote sensors (remote weather stations) deliver information to the Mount Washington Observatory.

PSU and UNH participated in the New Hampshire Tech Fest in October 2011, with booths, hands on activities, and demonstrations. NH TechFest is an all-day science

and technology extravaganza for middle and high school students and their families. Exhibits sponsored by Space Grant and UNH included a cloud chamber demonstration contributed by a Lunar Reconnaissance Orbiter (LRO) instrument team, the LunaCats (NASA Lunabotics Mining Competition team from UNH) demonstrating their lunar excavator, a dome showing the *Earth's Wild Ride* show, and activities based on NASA's new "Food for Thought" program. Approximately 600 attendees were registered for the event, with about half of attendance constituting K-12 students.

In October 2011, Space Grant teamed up with the UNH Department of Physics and the NH Astronomical Society to host the first ever New England Fall Astronomy Festival (NEFAF), a two-day event held at the UNH Observatory. The event attracted over 500 guests and included talks by amateur astronomers, professional scientists, and several events with NASA astronaut (and UNH alumnus) Lee Morin. Dr. Morin met with a group of 20 undergraduate and graduate students prior to his public event, with an hour and half Q&A period. He regaled the students and faculty mentors with fascinating discussions about the challenges and safety issues regarding Extravehicular Activities (EVAs), why he chose his particular career path, what his mission roles were as a NASA astronaut, the physics of docking the Shuttle with the ISS, and just a constant stream of unique tales of life in the corps, including the "smell of space" and his experience of seeing radiation-induced flashes of light in his own eyes while in orbit. At the public event, Dr. Morin presented an excellent presentation to an engaged and appreciative audience in the big tent of the New England Fall Astronomy Festival. His talk was "Transforming Fantasy - Building a Space Station". He was able to make personal connections with NH and UNH during the talk, including showing a movie he took from the Shuttle of the aurora borealis. After a lively Q&A session, he then spent an hour or so signing autographs for the large gathering of astronomy enthusiasts from around New England. The final event with Dr. Morin was an hour-long panel, loosely around the topic of the future of human space exploration.

A new Facebook page "NHWomeninScienceandTechnology" was launched by the NHSGC program coordinator. The page content focuses on events of potential interest to women students in science and technology, including profiles of NH women in STEM (Science, Technology, Engineering, Mathematics) careers. After its first year of operation, there were 170 "likes" recorded.

Priming the Pump -- Informal Educator Development

MSDC staff participated in science conferences to increase content knowledge and effectiveness of the Center's educational programs, planetarium shows and exhibits. The MSDC Astronomy Educator participated in the Association of Science-Technology Centers Annual Meeting and Conference in Baltimore MD, where she was able to interact with NASA scientists and educators from the Space Telescope Science Institute. She networked and built relationships with informal STEM education peers that enable collaborations and reaching more people with more resources in the present and future. The MSDC Producer (of exhibits and planetarium shows) and the MSDC Astronomer (and webmaster) participated in the Mutual Concerns of Air and Space Museums Annual

Conference in Dayton OH, where they increased their content information on aviation technology, observed aviation displays and exhibits, and developed a network of peers and providers that enabled them to head up the Discovery Center's project of transporting a major vintage aircraft (one from a series tested by Mercury Astronauts Alan Shepard and John Glenn) from Texas to NH, arranging for riggers to move the craft from the trucks to the exhibit floor, and clean and prepare the plane for exhibit. They will be able to better plan future exhibits that will engage the public about the past, present and future of aviation due to their increased content knowledge and peer network.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Student Data and Longitudinal Tracking:

Total awards = 78; Fellowship/Scholarship = 43, Higher Education/Research Infrastructure = 35; 5.1% of the total awards (9.3% of the F/S awards) represent underrepresented minority F/S funding. During the FY11 program year 17 are pursuing advanced degrees in STEM disciplines, 3 accepted STEM positions at NASA contractors, 3 accepted positions at NASA, 21 accepted STEM positions in industry, 7 accepted STEM positions in K-12 academia, 7 accepted STEM positions in academia, and 6 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing while they received their Space Grant award.

- Diversity:

There are no minority-serving institutions in New Hampshire. At 9.3% of F/S awardees, under-represented (non-Asian) minority students receiving Space Grant support in the State's institutions of higher learning exceeds the New Hampshire non-Asian/non-Pacific Islander minority higher education enrollment of 5.4% in ethnic diversity. Of the faculty mentors, one is Hispanic, and two are of Asian (including Indian) heritage.

Within the NHSGC central administration, the Director, Assistant Director, Program Coordinator, Graphics Communications Specialist, and Business Manager are female. The affiliate Space Grant program directors for Community Colleges of New Hampshire Foundation, FIRST, Rey Center, and the MSDC are female. Of all student awardees, 47.4% are female, 44.2% female within F/S. Female faculty mentor 13 students awardees, or 16.7%. In particular, the Dartmouth College WISP program specifically engages and sustains female undergraduates in the STEM disciplines with extended mentoring by faculty and specialized events relating to retention within STEM careers.

Disability demographics are not routinely available, but at least 2 students indicated disabilities.

- **Minority-Serving Institutions:**

NHSGC maintained its initiative with Elizabeth City State University, a historically black university (HBCU) in North Carolina. Stricter requirements were put into place this year, and as a result only one student participated.

- **NASA Education Priorities:**

- *Authentic, hands-on student experiences in science and engineering disciplines:*

All graduate fellowships at Dartmouth College, University of New Hampshire, Plymouth State University and graduate and undergraduate internships from these institutions as well as from the McAuliffe-Shepard Discovery Center include significant elements of authentic hands-on experience in cutting edge STEM research for higher education students. These activities include the mentorship of faculty engaged in the research. Sample activities include the Magnetospheric Multi-Scale Mission TableSat prototype, sounding rocket data analysis, design of lunar rover components, and weather research for KSC launch operations.

The Rey Center's K-12 supplemental science (K-12) curriculum programs, MWO field trips, FIRST Robotics Competition, and UNH's Forest Watch incorporate hands-on learning and concept integration of scientific methodology and engineering practices for pipeline (pre-college) students.

- *Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise.*

The "Science Teacher Training North Country" initiative provided hands-on exposure for middle school teachers to UNH scientists engaged in NASA research for the purpose of curriculum enhancement; 69% have since reported incorporating the materials into their classrooms. The MWO and Rey Center provide curriculum-enhancing modules to pre-college teachers on Phenology and Climate, Mountain Weather, and Climate Change.

- *Summer opportunities for secondary students on college campuses.*

White Mountains Community College hosted a Science, Technology, Engineering, and Mathematics camp (July 11 & July 18, 2011). The STEM camp, designed for students entering grades 6 through 8, provided hands-on, fun-filled activities that are meant to be introductory, interactive, and project-based.

➤ *Community Colleges*

White Mountains Community College initiative for the WIST Forum at WMCC created new relationships with FIRST, UNH, and Dartmouth College students and faculty.

➤ *Aeronautics research*

Thesis and intern projects sponsored by Space Grant include attitude control for the NASA MMS Mission and lunar rover components. A new engineering course on Fundamentals of Space Systems was developed and taught in the 2012 winter quarter at Dartmouth College.

➤ *Environmental Science and Global Climate Change*

UNH and Dartmouth College graduate students in Natural Resources and Earth Science Departments conducted research on global climate change topics such as (1) the chemistry of the aerosols in the atmosphere, (2) the release of methane as bubbles from peat lands and the adjacent lakes, (3) impact of arc terrain weathering on the global cycles of various elements; and (4) real-time observations of the Greenland under-ice environment.

The Rey Center's Phenology and Climate (K-12) curriculum incorporates concepts related to seasonality, global climate change, and ecosystem function, while the Tecumseh Overnights Program provides an introduction to northeastern temperate forests, seasonality, climate change, and anthropogenic influences on earth's environment to general public participants.

➤ *Diversity is discussed above.*

➤ *Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities.*

The *Young Visiting Scientist* program at Dartmouth College and the new *UNH NASA Research Initiative* enable young faculty by supporting research infrastructure activities relevant to NASA. One Dartmouth faculty Physics member and two UNH faculty members (Physics and Earth Science) were supported this past year.

IMPROVEMENTS MADE IN THE PAST YEAR

At the end of June 2011, Prof. David Bartlett, founding Director of the New Hampshire Space Grant Consortium, retired after twenty years of guiding Space Grant activities in New Hampshire. The new director is Prof. Antoinette Galvin, a space physicist and faculty member of the Department of Physics and the Space Science Center at the University of New Hampshire. Dr. Galvin had been the Assistant Director for NHSGC since 1999. As part of the ongoing re-organization, Dr. Kristin Simunac, a young scientist who received her PhD degree in 2009, has become the Assistant Director. Ms. Kristi Donahue has been brought onboard as a graphics communications specialist and is the NHSGC's Webmaster. Prof. Marc Lessard of the Space Science Center has joined the team (on match support) to foster research and student partnerships with the regional space and aerospace industries.

One major change during this past year was in not having the PSU students go to CCAFS/KSC for summer internships. This was primarily due to changes in management at Cape Canaveral Air Force Station, where the research is conducted, which led to a lack of desk space. New management has come in; personnel from the KSC weather office want the PSU contingent back, and space has been designated for resumption of activities this coming summer. The current year KSC internship funding was re-directed towards graduate student support.

The MWO initiated a new program entitled "Techno in the Tundra". This is a follow-up and companion to their environmental "Alpine Zone" program. MWO received an Honorable Mention from the Center of Interactive Learning and Collaboration in regard to their Distance Learning program. The award is presented annually to content providers who post top-ranking programs to www.cilc.org for K-12 students or professional development of educators. This award is based exclusively on feedback from teachers who have used the content in their classrooms or for their own professional enhancement. As a result of this award, the MWO long-distance learning program has received an increase in requests for the program. Through evaluation and feedback, teachers are finding this program as a useful tool in the classroom and have returned for more programs. Each teacher receives an evaluation form, which asks questions about the material and presentation of the program. Their feedback is very helpful in designing future programs.

After a year of development and planning, Space Grant and the UNH Department of Education launched its new "Science Teacher Training North Country" for serving middle school teachers in rural areas of the state.

In the first year of the grant, MSDC's aerofestival event was run on three consecutive days. It was decided last year to focus on a two-day event, to best use staff resources, keep partner energy focused, and strongly market the event. MSDC eliminated inclusion of partners who were not STEM-related, maximizing use of event space for STEM related organizations and activities. This past year, MSDC also revised their special intern project to include a clear pathway to learning about career opportunities and possible connection with future employers. Past MSDC internships presented opportunities for the interns to meet scientists and engineers but not in such a targeted

manner. Another task, the overall program evaluation project at MSDC, was not completed, because a formal evaluator could not be attracted for the amount of funds allocated. It is planned to combine these funds with other support to be able to attract a professional evaluator for this coming summer's Space Grant-funded activities.

The CCSNH increased the number of scholarship applications by nearly 13% over last year's application pool. The Community Colleges of New Hampshire Foundation is the entity for managing the funds and grants secured by all of the seven colleges within the New Hampshire Community College System. The Foundation's mission is to support the colleges by making higher education more accessible. With this portion of the NASA Space Grant, the objective was to raise awareness of how the Community Colleges can be a pathway to NASA opportunities by aggressively marketing the NASA scholarships in pamphlets, posters, and press releases.

A new program was initiated at UNH to support faculty by developing infrastructure for research projects, with encouragement to establish new collaborations with NASA centers. Two such projects were awarded. One has reached completion and has already resulted in new proposals and collaborations with NASA, as well as supporting a Master's degree for one student.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The NHSGC has nine members. The lead institution is the University of New Hampshire, including UNH Cooperative Extension, with associate Dartmouth College, and affiliates FIRST Place, the Community College System of New Hampshire, the McAuliffe-Shepard Discovery Center, Plymouth State University, the Mount Washington Observatory, the Margret and H.A. Rey Center, and BAE Systems of North America.

The University of New Hampshire (UNH), located in Durham, NH, is the state's flagship research university, enrolling 11,942 undergraduates (55% female) and 2257 graduate students. Research and PhD programs relevant to aerospace are offered in physics, engineering, math, computer science, and a cross-college program in natural resources and Earth system science.

A part of UNH is Cooperative Extension that provides NH citizens with research-based education and information, enhancing their ability to make informed decisions that strengthen communities, sustains natural resources, and improves the economy. Space Grant collaborations are in the areas of geospatial technology and applications, resource management, and workforce development.

Dartmouth College, located in Hanover, NH, is a private liberal arts college (ninth oldest in the nation) and a member of the Ivy League. The college has 4,200 undergraduate students, 1,900 graduate students, and 600 tenure/tenure-track faculty. Aerospace-related undergraduate and doctoral degree programs are offered in physics and

astronomy, engineering, computer science, and Earth science. Extensive research is conducted in solar-terrestrial physics, astronomy, satellite remote sensing, robotics, and computer science applications.

The Community College System of New Hampshire (CCSNH, formerly the New Hampshire Community Technical College System) is New Hampshire's statewide system of two-year colleges, offering associate degrees, professional training, and transfer pathways to four-year degrees. CCSNH is comprised of seven colleges within the state: Great Bay Community College in Portsmouth; Lakes Region Community College in Laconia; Manchester Community College in Manchester; NHTI-Concord's Community College in Concord; Nashua Community College in Nashua; River Valley Community College in Claremont and Keene; White Mountains Community College with locations in Berlin, Conway, and Littleton. CCSNH is the primary provider of skilled workers and technicians in the State. Space Grant supports a NASA scholarship program for STEM students, linked to the private sector and also supports STEM curriculum development within the college system.

Plymouth State University (PSU), located in Plymouth, NH, is part of the University System of New Hampshire and has a current student enrollment of about 4300 undergraduates and 3000 graduate students. Space Grant funding provides research-oriented scholarships and fellowships in the meteorology program, with an emphasis on providing support to women undergraduate students.

FIRST Place is an innovative R&D facility in Manchester, NH, linked to Dean Kamen's nationwide FIRST robotics programs. It provides students, teachers, and the general public an encouraging environment for exploring concepts of science and technology. FIRST Place collaborates with UNH in curriculum development for pre-college science teachers. UNH and BAE Systems provide mentors and support for NH school teams involved in FIRST competitions.

The Mount Washington Observatory (MWO), in the White Mountains of NH, is a non-profit organization providing environmental observation and education while supporting scientific research. Current research projects address summit weather and climate, regional air quality, and global tropospheric chemistry. MWO, UNH, and PSU work together on many Space Grant activities, including internships and research projects.

The mission of the McAuliffe-Shepard Discovery Center (MSDC), located in Concord, NH, is *to educate, incite, and entertain learners of all ages in the sciences and humanities by actively engaging them in the exploration of astronomy, aviation, and Earth and space science*. As many as 60,000 school children and other visitors explore the Planetarium annually. The Planetarium is NASA's Educator Resource Center for NH. Space Grant supports the development of Planetarium shows and exhibits, teacher workshops, and space science fairs, often in collaboration with other NHSGC affiliates.

The Margret and H.A. Rey Center, in the Waterville Valley, honors the legacy of

Margret and Hans Rey, authors of Curious George books and *The Stars, a New Way to See Them*, among other works. The Rey Center provides initiatives in environmental stewardship and informal educational programs in the astronomy and local ecological systems. NHSGC resources are used by the Rey Center to initiate several citizen science community outreach programs and cooperative research initiatives. Among these are the Tecumseh Overnights Program, Tecumseh Vegetation Phenology Research Transect, the Lorenz Weather Station, and the Water Watchers water quality-monitoring program.

BAE Systems of North America is part of an international company that develops and supports advanced defense and aerospace systems, and is headquartered in Nashua, NH. As our first industrial partner, BAE Systems provides internship opportunities for undergraduate and graduate students from our consortium's academic institutions. BAE Systems also supports and mentors teams for FIRST Robotics, FIRST Tech Challenges, and FIRST Lego League.